PATENT SPECIFICATION (11) 1205009

1205009

DRAWINGS ATTACHED

(21) Application No. 37304/69 (22) Filed 24 July 1969

(31) Convention Application No. 755 080 (32) Filed 26 Aug. 1968 in

(33) United States of America (US)

(45) Complete Specification published 9 Sept. 1970

(51) International Classification F 16 h 3/44

(52) Index at acceptance

F2D 2C4B3 2D4 2D5 2D6B 2D7

B3A 105

(54) PLANETARY GEARING ARRANGEMENTS

(71) We, GENERAL MOTORS CORPORATION, a Company incorporated under the laws of the State of Delaware, in the United States of America, of Grand Boulevard, in the City of Detroit, State of Michigan, in the United States of America (Assignees of CHARLES RUSSELL MOORE) do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to planetary gearing arrangements, for example epicyclic gear units such as are usable in variable-ratio power transmission mechanisms of motor vehicles.

The invention is primarily concerned with a compact planetary carrier that can be constructed relatively inexpensively from sheet metal components.

The appended claims define the scope of the invention claimed. The invention and how it can be performed are hereinafter particularly described with reference to the accompanying drawings, in which:—

Figure 1 is a fragmentary longitudinal section of one embodiment of a planetary gearing arrangement in accordance with the present invention;

Figure 2 is an end view, partly in section, from the line 2—2 of Figure 1, in the direction of the arrows;

Figure 3 is an isometric view of a planetary carrier forming part of the planetary gearing arrangement shown in Figures 1 and 2;

Figure 4 is an end view similar to Figure 2 but showing a second embodiment of a planetary gearing arrangement in accordance with the invention, including a modified form of planetary carrier;

Figure 5 is a fragmentary section on the line 5—5 of Figure 4 in the direction of the arrows; and,

Figure 6 is an isometric view of the modified form of planetary carrier.

The embodiment of the planetary gearing arrangement in accordance with the invention which is shown in Figures 1 to 3 of the drawings includes a planetary carrier 20 having two end walls 22 and 24 formed by sheet metal flanges having equal outer diameters, a sheet metal central plate 26, and a plurality of sheet metal spacers 28 in the form of straps joining the end walls 22 and 24. The flanges 22 and 24 have slots 30 into which are fitted tangs 32 of the spacers 28 which are segments of cylinders, that is, have a part-annular cross-section. The central plate 26 has a plurality of lobe portions 34, each having a tang 36 at the perimeter thereof. The tangs 36 are located in slots 38 of the spacers 28. The spacers 28 are secured by welding to the flanges 22 and 24 and to the central plate 26, to form a unitized sheet metal carrier 20. The flanges 22 and 24 each have a plurality of respective apertures 40 and 42 which are axially aligned substantially centrally of the openings or spaces between adjacent lobes 34 of the central plate 26. The flange 24 also has a plurality of apertures 44 which are axially aligned with apertures 46 in the lobe portions 34.

As is shown in Figure 1, long pinion pins 48 are secured in the apertures 40 and 42 and have rotatably mounted thereon, by means of bearings 50, respective long pinions 52. Meshing with the long pinions 52 are a plurality of short portions 54 which are rotatably mounted by bearings 56 on short pins 58, which are secured in the apertures 44 and 46. Also meshing with the long pinions 52 is a ring gear 60 which is outside the perimeter of the carrier 20, and a reaction sun gear 62 which extends through a central opening 64 in the flange 22. An input sun gear 66 meshes with the short pinions 54, and extends through a central opening 68 in the flange 24. An output shaft 70 is secured by welding to the central plate 26, and extends to the right (as viewed in Figure 1) through the reaction sun gear 62.

The apertures 40 and 42 are located on a

pin centre circle 72 on the flanges 22 and 24, between the inner and outer perimeters of the flanges. The spacers 28 are located adjacent the outer perimeter of the flanges 22 and 24 and have a circumferential dimension which permits the pin centre circle 72 to be sufficiently distant from the centre of the flanges 22 and 24 for the pinions 52 and 54 to have the largest possible diameter for a given size carrier, thus increasing the rigidity and torque capacity of the carrier. Also, the pin centre circle 72 is so located as to permit the root diameter of the long pinions 52 to extend slightly beyond the circumference of the spacers 28 and the outer perimeter of the flanges 22 and 24. Thus, when the spacers 28 are located at a planetary gear radius larger than the radius of the pin centre circle 72 and the radius to the outermost portion of the short pinions 54 and less than the root diameter of the ring gear 60, there is no carrier structure between the pinions requiring that the pinions be spaced; therefore a maximum number of pinions having a maximum size can be used in any gear set. The spacers 28 are located just within the inside diameter of the ring gear so that they have a maximum circumferential width. This construction provides a planetary gear set of minimum size and maximum rigidity in relationship to the torque capacity.

The apertures 44 are located on a smaller-diameter pin centre circle 74 on the flange 24. The diameters of the pinions 52 and 54 are such that the area between the pin centre circles 72 and 74 is substantially filled by the pinions.

Figures 4 to 6 of the drawings show a modified form of planetary carrier 120, which comprises a central plate 122 and two cup-shaped outside members 124 and 126. The central plate member 122 has a plurality of lobe portions 128 each having an aperture 130 therein, with a gear opening or space between adjacent lobe portions. The cup-shaped member 124 comprises a flange 132 and a plurality of concentric part-drum portions 134 which extend inwardly from the flange 132 and are welded to the central plate 122, and thereby form spacers between the central plate and the flange 132. The flange 132 has a plurality of apertures 136 which are aligned with the gear openings 131 between the lobes 128, and also has a plurality of semi-circular slots 138 (Figure 4) at the inner periphery thereof which are aligned with the apertures 130. Because the part-drum portions 134 are discontinuous between the lobes 128, openings are formed at the outer periphery of the planetary carrier 120.

The cup member 126 is similar to the cup member 124, and has a flange 140 and a plurality of discontinuous part-drum portions 142 which extend inwardly from the flange portion 140 and are also welded to the outer perimeter of the central plate 122, to form spacers of part-annular cross-section between the central plate and the flange 140. The flange portion 140 has a plurality of apertures 144 which are axially aligned with the apertures 136, and a plurality of apertures 146 which are aligned with the apertures 130 and the semi-circular slots 138. As is shown in Figure 5, the central plate 122 has two grooves 148 and 150 at its outer perimeter in which are located the inner edges of the part-drum portions 142 and 134.

The planetary carrier 120 is arranged as the output member of a planetary gear set which, as is shown in Figure 4, is similar to the planetary gear set as described above and shown in Figures 1 and 2. In detail, the planetary gear set shown in Figure 4 includes an input sun gear 152, a reaction sun gear 154, an input and reaction ring gear 156, a plurality of long pinion gears 158 meshing with the sun gear 154 and the ring gear 156, and a plurality of short pinions 160 meshing with the sun gear 152 and the long pinions 158. The long pinions 158 are rotatably mounted on pins 162 which are located in the apertures 136 and 144, thus locating the long pinions in the gear openings 131 between the lobe portions 128. The short pinions 160 are rotatably mounted on pins 164 between the cup member 126 and the central plate 122. The pins 164 are located in the apertures 146 and 130 and in the semi-circular slots 138.

The axial location of the pins 162 and 164 is maintained by a locking plate 166 which has a plurality of locking slots 168 and cam slots 170. The locking slots 168 each have a circular portion 172, a circumferential portion 174 which is tangential to the circular portion 172 and the respective pin 162, and a locking portion 176 for engaging a groove 178 in the pin 162. The cam slots 170 each have a part-circular portion 180, and a cam portion 182 for engaging a slot 184 in the respective pin 164. After the pinions 158 and 160 have been mounted in the carrier on the pins 162 and 164 respectively, the locking plate 166 is placed over the pins so that the circular portions 172 and 180 are aligned with the pins 162 and 164. The locking plate 166 is then rotated in the direction of the arrow *A* in Figure 4 until the locking portion 176 engages the slot 178 and the cam portion 182 engages the slot 184. The locking plate 166 is then secured to the cup member 124 by means of fastener bolts 186.

The apertures 136 and 144 are located on a pin centre circle 72′ and the apertures 146 are located on a pin centre circle 74′ in a manner similar to that described above for the carrier 20. Therefore the carrier 120 possesses compactness and high torque capacity in the same way as has been described for the carrier 20.

In a prior type of planetary carrier construction, a central member is drivingly connected

to a shaft and two outside members are secured together and to the central member by means of pins on which the planetary pinions are mounted. Thus the pins not only carry the torque transmitted by the carrier, but also must support gear end loading which results from the engaged gear teeth. This gear end loading can be substantial in modern planetary gears using helical gear teeth.

With a planetary carrier in conformity with the present invention, the location of the spacers at the outer perimeter permits the use of more and larger-diameter pinion gears with a relatively small-diameter carrier. Such increase in the number and size of the pinion gears allows the transmission of higher torque components without increase in the overall size of the carrier. The structural strength of the carrier is also improved by the location of the spacers at the outer perimeter, since this permits the use of spacers having a longer circumferential portion without unduly limiting the size, number and location of the pinion gears.

Also, a planetary carrier in conformity with the present invention can be fabricated complete from its sheet metal components before the pinion gears are installed, since it does not rely on the pinion pins to secure the central and outside members together. This construction also provides a more rigid carrier which can be used in epicyclic gearing (that is, planetary gearing including a ring gear) having a central output from the carrier.

The planetary carrier in conformity with the invention can readily be constructed from sheet metal by simple stamping and welding operations, and can give a substantial cost saving in terms of material used, manufacturing costs, and transport costs as compared with the prior type of carrier made of cast iron elements bolted together.

WHAT WE CLAIM IS:—

1. A planetary gearing arrangement comprising a planetary carrier made of a central sheet metal plate which is centrally apertured for connection to an output shaft, and a pair of centrally apertured sheet metal flanges which form end walls of the planetary carrier and are connected at their external peripheries to the external peripheries of lobe portions of the central plate by means of respective sheet metal spacers of part-annular cross-section.

2. A planetary gearing arrangement comprising a planetary carrier made of a central sheet metal plate which is centrally apertured for connection to an output shaft, and a pair of centrally apertured sheet metal flanges which form end walls of the planetary carrier and are connected at their external peripheries to the external peripheries of lobe portions of the central plate by means of respective sheet metal spacers of part-annular cross-section, the central plate having respective openings between adjacent lobe portions for the reception of long planetary pinion gears and the flanges having a first set of aligned apertures for the reception of mounting pins for the long pinion gears, and the central plate and one of the flanges having a second set of aligned apertures for the reception of mounting pins for short planetary pinion gears meshing with respective ones of the long pinion gears, the apertures of the first and second sets being arranged in alternating sequence with the centres of the apertures of the first set arranged on a larger-diameter circle than the centres of the apertures of the second set.

3. A planetary gearing arrangement according to claim 2, in which long planetary pinion gears are mounted on pins whose ends extend into the aligned apertures of the first set, short planetary pinion gears mesh with respective ones of the long pinion gears and are mounted on pins whose ends extend into the aligned apertures of the second set, and a portion of the root diameter of each of the long planetary pinion gears projects between the adjacent spacers and extends beyond the external peripheries of the flanges.

4. A planetary gearing arrangement according to claim 3, in which an output shaft extends into the central aperture in the central plate and is secured to the plate, an input sun gear disposed coaxially with the output shaft meshes with the short planetary pinions and is piloted relative to the output shaft, a ring gear meshes with the long planetary pinions, and a hollow sun gear coaxially surrounding the output shaft also meshes with the long planetary pinions.

5. A planetary gearing arrangement according to claim 3 or 4, in which the mounting pins include slots that are engageable by locking plates for locking the mounting pins in position.

6. A planetary gearing arrangement according to any one of claims 1 to 5, in which the sheet metal spacers are formed separately from the flanges forming the end walls of the planetary carrier, and are connected to the central plate and to the flanges by means of tang-and-slot connections.

7. A planetary gearing arrangement according to any one of claims 1 to 5, in which the sheet metal spacers and the flanges forming the end walls of the planetary carrier form parts of a pair of sheet metal cup-shaped members that are disposed on opposite sides of the central plate and are connected to external peripheral portions of the central plate.

8. A planetary gearing arrangement substantially as hereinbefore particularly described and as shown in Figures 1 to 3 of the accompanying drawings.

9. A planetary gearing arrangement substantially as hereinbefore particularly described and as shown in Figures 4 to 6 of the accompanying drawings.

D. H. O. WORKMAN,
Chartered Patent Agent.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1970.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1205009 'COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig.1

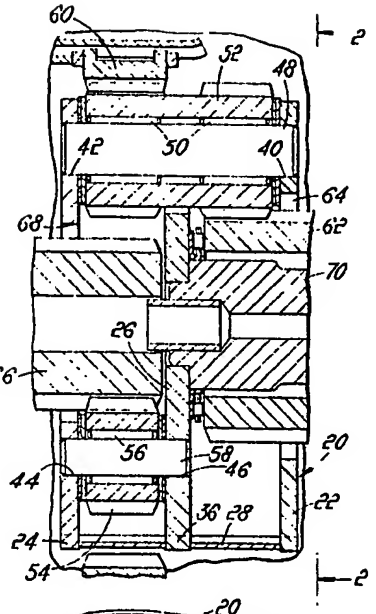
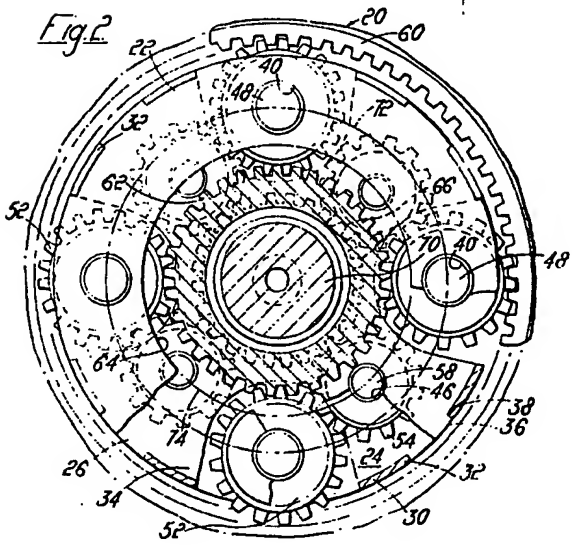


Fig.2



1205009 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

Fig 3.

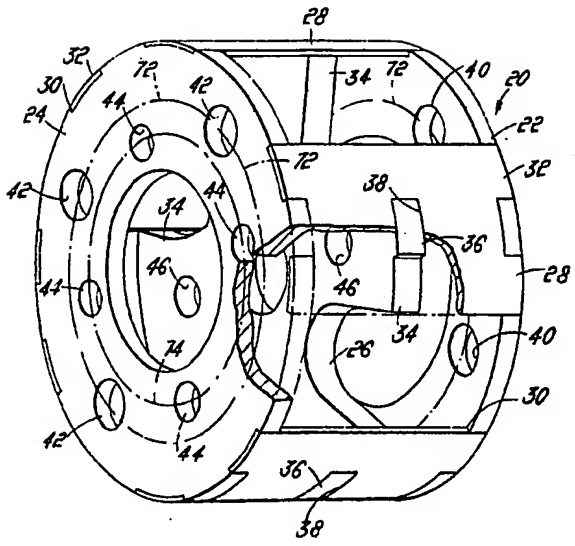
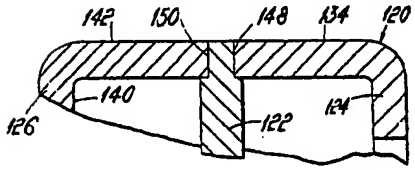
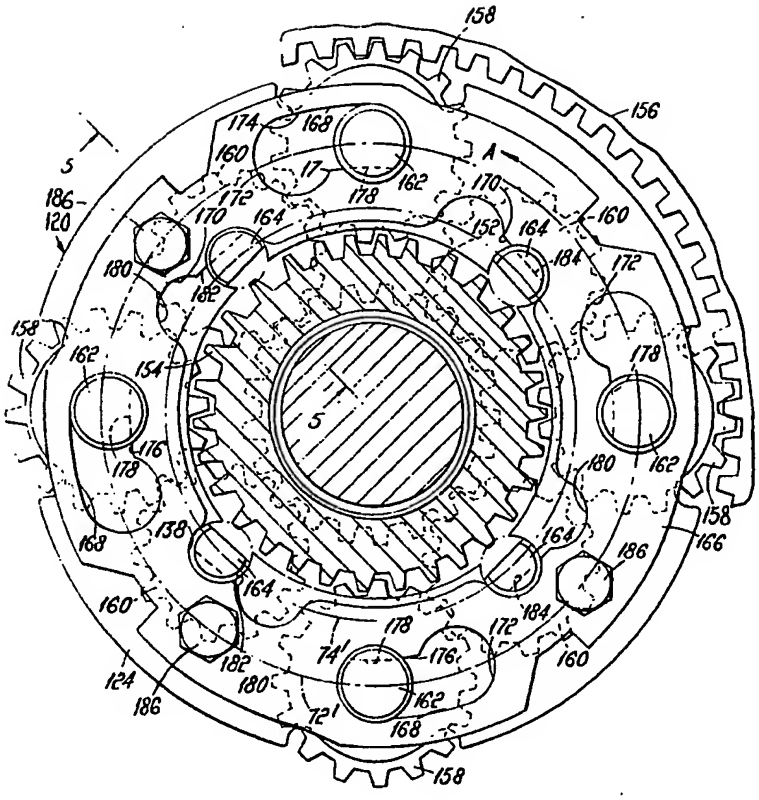


Fig 5



1205009 'COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 3

Fig4



1205009 'COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 4

Fig.6